

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room  
CP2/5C24  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE  
in its capacity as elected Office

Date of mailing (day/month/year) 06 March 2001 (06.03.01)	
International application No. PCT/FI00/00620	Applicant's or agent's file reference 50242
International filing date (day/month/year) 06 July 2000 (06.07.00)	Priority date (day/month/year) 09 July 1999 (09.07.99)
Applicant KORPELA, Sari et al	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

06 February 2001 (06.02.01)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer C. Cupello Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422).

From the INTERNATIONAL BUREAU

To:

BERGGREN OY AB  
P.O. Box 16  
FIN-00101 Helsinki  
FINLANDE

Date of mailing (day/month/year) 19 December 2001 (19.12.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 50242	
International application No. PCT/FI00/00620	International filing date (day/month/year) 06 July 2000 (06.07.00)

## 1. The following indications appeared on record concerning:

☒ the applicant
 ☐ the inventor
 ☐ the agent
 ☐ the common representative

## Name and Address

NOKIA MOBILE PHONES LTD.  
Keilalahdentie 4  
FIN-02150 Espoo  
Finland

## State of Nationality

FI

## State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person
 ☒ the name
 ☐ the address
 ☐ the nationality
 ☐ the residence

## Name and Address

NOKIA CORPORATION  
Keilalahdentie 4  
FIN-02150 Espoo  
Finland

## State of Nationality

FI

## State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

François BAECHLER

Telephone No.: (41-22) 338.83.38

## PCT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

BERGGREN OY AB  
P.O. Box 16  
FIN-00101 Helsinki  
FINLANDE

2002

Date of mailing (day/month/year)

19 December 2001 (19.12.01)

Applicant's or agent's file reference

50242

International application No.

PCT/FI00/00620

International filing date (day/month/year)

06 July 2000 (06.07.00)

## IMPORTANT NOTIFICATION

1. The following indications appeared on record concerning:



the applicant



the inventor



the agent



the common representative

Name and Address

NOKIA MOBILE PHONES LTD.  
Keilalahdentie 4  
FIN-02150 Espoo  
Finland

State of Nationality

FI

State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:



the person



the name



the address



the nationality



the residence

Name and Address

NOKIA CORPORATION  
Keilalahdentie 4  
FIN-02150 Espoo  
Finland

State of Nationality

FI

State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:



the receiving Office



the International Searching Authority



the International Preliminary Examining Authority



the designated Offices concerned



the elected Offices concerned



other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

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Authorized officer

François BASCHLER

Telephone No.: (41-22) 338.83.38

02 • PATENTIT  
SMALLIT  
• PATENTS  
UTILITY MODELS

**Patent- och registreringsverket**  
**Valhallavägen 136**  
**P.O. Box 5055**  
**S-102 42 STOCKHOLM**  
**Sweden**

**FAX: 999 46 8 667 7288 (7 pages)**  
**(Confirmation by mail)**

Authorized Officer: Peder Gjervaldsaeter/MN  
Our ref: 50242/SKU/PKK

**REPLY TO WRITTEN OPINION**  
**INTERNATIONAL PATENT APPLICATION PCT/FI00/00620**  
**APPLICANT: NOKIA MOBILE PHONES LTD.**  
**Due Date: 25 August 2001**

In response to the Written Opinion the independent claims of the application are amended and the following arguments are respectfully presented.

The independent claims 1, 12 and 13 are amended to specify that when a partial transmission pattern is used in a frame, the transmission pattern is started from the beginning in the beginning of a next frame. Support for this amendment is found in the following parts of the description: page 10, row 32 – page 11, row 4 and page 11, rows 11–13. The enclosed dependent claims are original.

The description is brought into conformity with the amended claims by the enclosed replacement pages 7 and 7a. No other changes than those relating to the amended claims are made to the description.

Document D4 discloses (on page 6, rows 3- 7, in Table 1 and in claim 9) an identical way to transmit a sequence of symbols as is discussed on page 4, row 30 – page 5, row 5 of the present application. This transmission method is an example of a space time transmit diversity (STTD). Document D1 discusses time switched transmit diversity (TSTD), where number of antennas is used to transmit a sequence of symbols, one antenna at a time.

The present application discusses TSTD and, as an example, the transmission of synchronization symbols (Fig. 3 and pages 4-6). The problems relating to synchronization symbols and to the use of a frame having an odd number of time slots (or a frame whose length is not a multiple of the length of a transmission pattern) are discussed in the description on page 5, row 26 – page 6, row 18.

**Berggren Oy Ab**

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**Pankit • Bankers:**

NORDEA	157330-15411
SWFT	MRITFIHH
SAMPO	800017-90104
SWFT	PSPBEIHH

**Yhtiö • Company:**

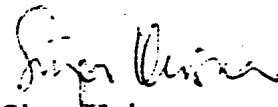
krnro	30.802
Trade Reg. No.	30.802
Y	0107002-7
VAT	FI01070027
Kotipaikka	Helsinki

In document D4, the transmission of a symbol pair  $s_0$  and  $s_1$  requires two time slots. Document D4 seems to assume that there is an even number of time slots in a frame, as there usually has been in various radio system. A frame having an odd number of time slots (or a frame whose length is not a multiple of the length of a transmission pattern) is not discussed in any of the documents cited in the Written Opinion; relating problems are not recognized therein. They thus do not provide hints towards a solution to the problems identified in the present application.

A reception of the symbols, which are transmitted using TSTD, may succeed tolerably (i.e. it is possible to determine, which symbol was transmitted) even if a symbol is not repeatedly transmitted using a known antenna; typically this results in a poorer quality of the received signal. For example, the reception of synchronization symbols in such a radio system, where frames have 15 time slots, may succeed tolerably, if a transmission pattern, whose length is two time slots, is plainly repeated irrespectively of the frame boundaries. Therefore it is not obvious that a modification to the transmission method is needed. The use of the claimed invention in such a radio system, however, makes the synchronization more rapid. This change in a method for transmitting a sequence of symbols has a strong effect on the system and enhances system performance.

It is argued that the claimed invention is novel and inventive. A reconsideration of the statement with regard to novelty and inventive step is therefore respectfully requested.

**BERGGREN OY AB**

  
Sirpa Kuisma  
Patent Attorney

Encl.

Replacement pages 7, 7a, 15-17

**Berggren Oy Ab**

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Kotipaikka Helsinki

\*European Patent Attorney  
\*\*European Trademark Attorney

- when a partial transmission pattern is used in the end of a frame, the transmission pattern is started from the beginning in the beginning of a next frame.

An arrangement according to the invention is an arrangement, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and

- starting means for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a frame.

A network element according to the invention is a network element, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and

- starting means for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a frame.

In a method according to the invention a sequence of symbol is transmitted using at least two antennas. The transmission of the symbols belonging to the sequence is characterized with a transmission pattern. Here the term transmission pattern refers to a pattern that specifies both from which antenna a symbol is transmitted and at which time the symbol is transmitted. The pattern may consist, for example, of a sequence of pattern items, and each of the pattern items corresponds to a certain period of time. A pattern item may be represented, for example, by a number indicating an antenna. For example, a pattern 1, 2, 0, 2, 2, 0, 1,..., where each number corresponds to a time slot, would indicate that a first symbol of the sequence is transmitted in a first time slot using a first antenna, a second symbol of the sequence is transmitted using a second antenna in a second time slot and in the third time slot no symbol belonging to the sequence is transmitted. In the fourth time slot, a third symbol of the sequence is transmitted using the second antenna, and so forth.

In the method according to the invention the antenna to transmit the first symbol belonging to the sequence is predefined. This means that a certain physical antenna is associated to the first antenna of the transmission pattern. The receiver thus

## Claims

1. A method (300, 400, 500) for transmitting a certain sequence of symbols, where
  - a frame is constructed of a certain number of consecutive symbols,
  - 5 - the symbols belonging to the sequence are transmitted (404, 502, 606) using at least two antennas and
  - the transmission of the sequence of symbols is characterized (401, 601) with a certain transmission pattern, **characterized** in that
  - the transmission of the sequence of symbols is started (402) from a predefined antenna and
  - 10 - when a partial transmission pattern is used in the end of a frame, the transmission pattern is started (403, 405) from the beginning in the beginning of a next frame.
2. A method (500, 600) according to claim 1, where
  - the length of the transmission pattern is shorter than the length of a frame, and
  - 15 - the length of the frame is not a multiple of the length of the transmission pattern, **characterized** in that during each frame
  - the transmission pattern is repeated (502) until the length of the rest of the frame, which length is the length of the transmission pattern multiplied by the number of the repetition times within the frame subtracted from the length of the frame, is less
  - 20 than the length of the transmission pattern and
  - thereafter only a certain part, whose length is the length of the rest of the frame, of the transmission pattern is used (503).
3. A method according to claim 2, **characterized** in that the part of the transmission pattern is selected (609) from the beginning of the transmission pattern.
- 25 4. A method according to claim 2, **characterized** in that the length of the transmission pattern is an even number and the length of the frame is an odd number.
5. A method according to claim 4, where the sequence of symbols is transmitted using a first antenna and a second antenna, **characterized** in that the transmission pattern is an alternating pattern and the length of the transmission pattern is two.
- 30 6. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, **characterized** in that one symbol belonging to the sequence of symbols is transmitted in each time slot.



7. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, **characterized** in that at least one symbol belonging to the sequence of symbols is transmitted in each time slot.
- 5 8. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, **characterized** in that at least in one of the time slots at least one symbol belonging to the sequence of symbols is transmitted.
9. A method according to claim 1, **characterized** in that the length of the transmission pattern is larger than the length of the frame.
- 10 10. A method according to claim 1, **characterized** in that the transmission of the sequence of symbols is started from the primary antenna that transmits the common pilot signal.
11. A method according to claim 1, **characterized** in that the sequence of symbols is transmitted in downlink direction in a cellular network.
- 15 12. An arrangement (700), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, **characterized** in that it further comprises
  - indication means (702) for indicating the antenna from which to transmit the first
  - 20 symbol belonging to the sequence and
  - starting means (703) for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a frame.
13. A network element (710), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, **characterized** in that it further comprises
  - indication means (702) for indicating the antenna from which to transmit the first
  - 25 symbol belonging to the sequence and
  - starting means (703) for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a
  - 30 frame.
14. A network element according to claim 13, **characterized** in that it is a radio network controller of a spread spectrum system.

15. A network element according to claim 13, characterized in that it further comprises at least two antennas (721, 722).
16. A network element according to claim 15, characterized in that it is a base station of a spread spectrum system.

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ SE

PCT

10/030286

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND
------------------------	---------------------------

<b>Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION</b>		Applicant's or agent's file reference 50242/SKU/PKK
International application No. PCT/FI00/00620	International filing date (day/month/year) 6 July 2000 (06.07.00)	(Earliest) Priority date (day/month/year) 9 July 1999 (09.07.99)

Title of invention Method for transmitting a sequence of symbols
---

<b>Box No. II APPLICANT(S)</b>	
Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country.  NOKIA MOBILE PHONES LTD. Keilalahdentie 4, FIN-02150 ESPOO, Finland	Telephone No.
	Facsimile No.
	Teleprinter No.

State (that is, country) of nationality: Finland	State (that is, country) of residence: Finland
---	---

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country.  KORPELA, Sari Forsellesintie 5-7 E 38, FIN-02700 KAUNIAINEN, Finland	
---	--

State (that is, country) of nationality: Finland	State (that is, country) of residence: Finland
---	---

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country.  KOIVISTO, Janne Kupittaankatu 141, FIN-20810 LOIMAA, Finland	
---	--

State (that is, country) of nationality: Finland	State (that is, country) of residence: Finland
---	---

<input checked="" type="checkbox"/> Further applicants are indicated on a continuation sheet.
---

RECEIVED 07 JAN 2002

Continuation of Box No **II** **APPLICANT(S)***If none of the following sub-boxes is used, this sheet should not be included in the demand*

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country: **JANSEN, Kaj**  
**Ristikedonkatu 34 A 4, FIN-24240 SALO, Finland**

State (that is, country) of nationality:  
**Finland**

State (that is, country) of residence:  
**Finland**

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country:

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country:

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country:

State (that is, country) of nationality:

State (that is, country) of residence:

☐ Further applicants are indicated on another continuation sheet

## Box No III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination ☐☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked ☐☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier ☐Name and address: (Family name followed by given name; for a legal entity, full official designation)  
(The address must include postal code and name of country)BERGGREN OY AB  
P.O. Box 16, FIN-00101 HELSINKI, Finland

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Teleprinter No

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent ☐

## Box No IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION

## Statement concerning amendments:\*

1 ☐ The applicant wishes the international preliminary examination to start on the basis of:☒ the international application as originally filedthe description ☒ as originally filed☐ as amended under Article 34the claims ☒ as originally filed☐ as amended under Article 19 (together with any accompanying statement)☐ as amended under Article 34the drawings ☒ as originally filed☐ as amended under Article 342 ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed ☐3 ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69(d)) ☐ (This check-box may be marked only where the time limit under Article 19 has not yet expired)\* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended ☐

Language for the purposes of international preliminary examination: English

☒ which is the language in which the international application was filed ☐☒ which is the language of a translation furnished for the purposes of international search ☐☒ which is the language of publication of the international application ☐☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination ☐

## Box No V ELECTION OF STATES

The applicant hereby elects all eligible States (that is, all States which have been designated and which are bound by Chapter II of the PCT)

excluding the following States which the applicant wishes not to elect:

## Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- |  |   |        |
|--|---|--------|
| 1 <input type="checkbox"/> translation of international application                              | : | sheets |
| 2 <input type="checkbox"/> amendments under Article 34   | : | sheets |
| 3 <input type="checkbox"/> copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4 <input type="checkbox"/> copy (or, where required, translation) of statement under Article 19  | : | sheets |
| 5 <input type="checkbox"/> letter  | : | sheets |
| 6 <input type="checkbox"/> other (specify)   | : | sheets |

For International Preliminary Examining Authority use only

received	not received
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

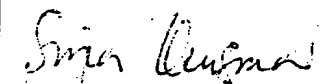
The demand is also accompanied by the item(s) marked below:

- |   |  |
|---|--|
| 1 <input checked="" type="checkbox"/> fee calculation sheet                             | 4 <input type="checkbox"/> statement explaining lack of signature                                  |
| 2 <input type="checkbox"/> separate signed power of attorney                            | 5 <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3 <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6 <input type="checkbox"/> other (specify):  |

## Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand)

BERGGREN OY AB



Sirpa Kuisma  
Patent Agent

HELSINKI, Finland, 6 February 2001

For International Preliminary Examining Authority use only

1 ☐ Date of actual receipt of DEMAND:

2 ☐ Adjusted date of receipt of demand due to CORRECTIONS under Rule 60I(b):

3 ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply

☐ The applicant has been informed accordingly

4 ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80I

5 ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82

For International Bureau use only

Demand received from IPEA on:

## PCT

## FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

International application No <span style="float: right;">PCT/FI00/00620</span> <hr/> Applicant's or agent's file reference <span style="float: right;">50242/SKU/PKK</span>	For International Preliminary Examining Authority use only  <div style="border: 1px solid black; height: 100px; width: 100%;"></div>	
Applicant <div style="text-align: center; font-weight: bold;">NOKIA MOBILE PHONES LTD.</div>		
<b>Calculation of prescribed fees</b>  <div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="width: 40%;"> <p>1 <input type="checkbox"/> Preliminary examination fee <span style="font-family: monospace; font-size: 0.8em;">XXXXXXXXXXXX</span></p> <p>2 <input type="checkbox"/> Handling fee <i>(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.)</i> <span style="font-family: monospace; font-size: 0.8em;">XXXXXXXXXXXX</span></p> <p>3 <input type="checkbox"/> Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box <span style="font-family: monospace; font-size: 0.8em;">XXXXXXXXXXXX</span></p> </div> <div style="width: 55%; text-align: right;"> <div style="border: 1px solid black; padding: 2px; display: inline-block;">SEK 4.200</div> <div style="border: 1px solid black; padding: 2px; margin-left: 5px;">P</div>   <div style="border: 1px solid black; padding: 2px; display: inline-block;">SEK 1.270</div> <div style="border: 1px solid black; padding: 2px; margin-left: 5px;">H</div>   <div style="border: 1px solid black; padding: 2px; display: inline-block;">SEK 5.470</div>  <div style="border: 1px solid black; padding: 2px; display: inline-block;">TOTAL</div> </div> </div>		
<b>Mode of Payment</b>  <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><input type="checkbox"/> authorization to charge deposit account with the IPEA (see below)</p> <p><input type="checkbox"/> cheque</p> <p><input type="checkbox"/> postal money order</p> <p><input checked="" type="checkbox"/> bank draft via SWIFT through account 5439-10-013-49</p> </div> <div style="width: 45%;"> <p><input type="checkbox"/> cash</p> <p><input type="checkbox"/> revenue stamps</p> <p><input type="checkbox"/> coupons</p> <p><input type="checkbox"/> other (specify):</p> </div> </div>		
<b>Deposit Account Authorization</b> <i>(this mode of payment may not be available at all IPEAs)</i>  The IPEA/ SE <span style="border: 1px solid black; padding: 0 10px;">  </span> <input type="checkbox"/> is hereby authorized to charge the total fees indicated above to my deposit account <input type="checkbox"/>  <div style="display: flex; align-items: center;"> <input type="checkbox"/> <i>(this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)</i> is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account <input type="checkbox"/> </div>		
Deposit Account Number <span style="border-bottom: 1px solid black; display: inline-block; width: 150px;"></span>	Date (day, month/year) <span style="border-bottom: 1px solid black; display: inline-block; width: 100px;"></span>	Signature <span style="border-bottom: 1px solid black; display: inline-block; width: 150px;"></span>

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 50242	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI00/00620	International filing date (day/month/year) 06.07.2000	Priority date (day/month/year) 09.07.1999
International Patent Classification (IPC) or national classification and IPC7 H 04 B 7/06		
Applicant NOKIA MOBILE PHONES LTD. ET AL.		

This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

This REPORT consists of a total of 6 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 06.02.2001	Date of completion of this report 16.10.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 33	Authorized officer Peder Gjervaldsæter/AE Telephone No. 08-782 25 00



## I. Basis of the report

1. With regard to the **elements** of the international application:\*

- ☐ the international application as originally filed
- ☒ the description:  
pages 1-6, 8-14 , as originally filed  
pages \_\_\_\_\_ , filed with the demand  
pages 7, 7a , filed with the letter of 27.08.2001
- ☒ the claims:  
pages \_\_\_\_\_ , as originally filed  
pages \_\_\_\_\_ , as amended (together with any statement) under article 19  
pages \_\_\_\_\_ , filed with the demand  
pages 15-17 , filed with the letter of 27-08-2001
- ☒ the drawings:  
pages 1-6 , as originally filed  
pages \_\_\_\_\_ , filed with the demand  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
pages \_\_\_\_\_ , as originally filed  
pages \_\_\_\_\_ , filed with the demand  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims. Nos. \_\_\_\_\_
- ☐ the drawings. sheet/fig \_\_\_\_\_

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. Statement:

Novelty (N)	Claims	<u>1-16</u>	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	<u>1-16</u>	NO
Industrial applicability (IA)	Claims	<u>1-16</u>	YES
	Claims		NO

## 2. Citations and explanations (Rule 70.7)

This report is based on new claims filed after the Written Opinion.

The claimed invention relates to transmission of a sequence of symbols using at least two antennas. According to the invention, the sequence is transmitted with a certain transmission pattern. A frame is transmitted by first transmitting the first symbol from a predefined antenna and then transmitting the rest of the symbols according to the transmission pattern, the transmission pattern starting from the beginning of each frame.

In the International Search Report the following documents were cited:

D1: IEEE 47<sup>th</sup> Vehicular Technology Conference 1997, Olofsson et al, "Transmitter diversity with antenna hopping.."

D2: IEEE, 49<sup>th</sup> Vehicular Technology Conference 1999, Raitola et al, "Transmission diversity in wideband CDMA"

D3: WO 9 608 908

In a complementary search this document was also found:

D4: WO 9 914 871

D1 describes a transmitter diversity system using antenna hopping. In D1 multiple antennas are used to transmit the signal according to a hopping pattern. Cyclic hopping, which evenly distributes the bursts of a speech frame on the available antennas, is used in D1. (See figure 1 and section III.)

D2 and D3 fail to describe the claimed invention.

.../...

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: BOX V

D4 describes a space time block coding system. According to D4, a sequence of symbols is transmitted from two antennas in a transmission pattern determined by the space time block code. (See page 6, line 15-19 and claim 9.)

From D4 is already known a space time block coding transmitter, which transmits symbols in a sequence according to a transmission pattern. The space time block code determines itself the actual transmission pattern as is shown in table 1 (page 6). It is from table 1 clear that the transmission of the sequence is started by transmitting the first symbol (S0) from a predetermined antenna (Antenna 11). The whole transmission pattern (of course also including transmission of the first symbol) for the sequence is thus clearly indicated by the coding matrix of the space time block code. It is not discussed in D4 how to handle a frame whose length is not a multiple of the length of a transmission pattern. But it is, however, considered obvious for a person skilled in the art to start the transmission pattern from the beginning in each frame. This would of course also mean that the transmission pattern is started from the beginning of a next frame after a partial transmission pattern is used in the end of a frame. What is claimed in claims 1, 12 and 13 is therefore not considered to involve an inventive step in view of what is already known from D4.

From D1 is also already known a transmitter diversity system that evenly distributes symbols in a frame on a plurality of antennas according to a hopping pattern. It is considered obvious for a person skilled in the art that the hopping pattern in D1 has a predetermined starting antenna from which the hopping pattern starts in every frame. Therefore, what is claimed in claims 1, 12 and 13 is not considered to involve an inventive step over what is already known from D1.

To repeat the transmission pattern until the end of the frame is considered obvious for a person skilled in the art and is not considered to involve an inventive step. Therefore, what is claimed in claim 2 fails to involve an inventive step.

What is claimed in claims 3-11 and 14-16 is considered to constitute details that are all considered obvious for a person skilled in the art. What is claimed in claims 3-11 and 14-16 is therefore not considered to involve an inventive step.

.../...

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V

The invention claimed in claims 1-16 is novel and comprises industrial applicability.

## VI. Certain documents cited

## 1. Certain published documents (Rule 70.10)

Application No.  
Patent No.Publication date  
(day/month/year)Filing date  
(day/month/year)Priority date (valid claim)  
(day/month/year)

WCNC.1999, Rajan Dinesh et al "Transmit Diversity  
Schemes for CDMA-2000"  
Publication data: 21-24 Sept, 1999

## 2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure

Date of non-written disclosure  
(day/month/year)Date of written disclosure  
referring to non-written disclosure  
(day/month/year)

- when a partial transmission pattern is used in the end of a frame, the transmission pattern is started from the beginning in the beginning of a next frame.

5 An arrangement according to the invention is an arrangement, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and
- 10 - starting means for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a frame.

15 A network element according to the invention is a network element, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and
- 20 - starting means for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a frame.

25 In a method according to the invention a sequence of symbol is transmitted using at least two antennas. The transmission of the symbols belonging to the sequence is characterized with a transmission pattern. Here the term transmission pattern refers to a pattern that specifies both from which antenna a symbol is transmitted and at which time the symbol is transmitted. The pattern may consist, for example, of a sequence of pattern items, and each of the pattern items corresponds to a certain period of time. A pattern item may be represented, for example, by a number indicating an antenna. For example, a pattern 1, 2, 0, 2, 2, 0, 1,..., where each number corresponds to a time slot, would indicate that a first symbol of the sequence is transmitted in a first time slot using a first antenna, a second symbol of the sequence is transmitted using a second antenna in a second time slot and in the third time slot no symbol belonging to the sequence is transmitted. In the fourth time slot, a third symbol of the sequence is transmitted using the second antenna, and so forth.

30

## Claims

1. A method (300, 400, 500) for transmitting a certain sequence of symbols, where
  - a frame is constructed of a certain number of consecutive symbols,
  - 5 - the symbols belonging to the sequence are transmitted (404, 502, 606) using at least two antennas and
  - the transmission of the sequence of symbols is characterized (401, 601) with a certain transmission pattern, **characterized** in that
  - the transmission of the sequence of symbols is started (402) from a predefined
  - 10 antenna and
  - when a partial transmission pattern is used in the end of a frame, the transmission pattern is started (403, 405) from the beginning in the beginning of a next frame.
2. A method (500, 600) according to claim 1, where
  - the length of the transmission pattern is shorter than the length of a frame, and
  - 15 - the length of the frame is not a multiple of the length of the transmission pattern, **characterized** in that during each frame
  - the transmission pattern is repeated (502) until the length of the rest of the frame, which length is the length of the transmission pattern multiplied by the number of the repetition times within the frame subtracted from the length of the frame, is less
  - 20 than the length of the transmission pattern and
  - thereafter only a certain part, whose length is the length of the rest of the frame, of the transmission pattern is used (503).
3. A method according to claim 2, **characterized** in that the part of the transmission pattern is selected (609) from the beginning of the transmission pattern.
- 25 4. A method according to claim 2, **characterized** in that the length of the transmission pattern is an even number and the length of the frame is an odd number.
5. A method according to claim 4, where the sequence of symbols is transmitted using a first antenna and a second antenna, **characterized** in that the transmission pattern is an alternating pattern and the length of the transmission pattern is two.
- 30 6. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, **characterized** in that one symbol belonging to the sequence of symbols is transmitted in each time slot.

7. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, **characterized** in that at least one symbol belonging to the sequence of symbols is transmitted in each time slot.
- 5 8. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, **characterized** in that at least in one of the time slots at least one symbol belonging to the sequence of symbols is transmitted.
- 10 9. A method according to claim 1, **characterized** in that the length of the transmission pattern is larger than the length of the frame.
10. A method according to claim 1, **characterized** in that the transmission of the sequence of symbols is started from the primary antenna that transmits the common pilot signal.
- 15 11. A method according to claim 1, **characterized** in that the sequence of symbols is transmitted in downlink direction in a cellular network.
- 20 12. An arrangement (700), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, **characterized** in that it further comprises  
- indication means (702) for indicating the antenna from which to transmit the first symbol belonging to the sequence and  
- starting means (703) for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a frame.
- 25 13. A network element (710), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, **characterized** in that it further comprises  
- indication means (702) for indicating the antenna from which to transmit the first symbol belonging to the sequence and  
- starting means (703) for starting the transmission pattern from the beginning in the beginning of a next frame, when a partial transmission pattern is used in the end of a frame.
- 30 14. A network element according to claim 13, **characterized** in that it is a radio network controller of a spread spectrum system.



15. A network element according to claim 13, **characterized** in that it further comprises at least two antennas (721, 722).

16. A network element according to claim 15, **characterized** in that it is a base station of a spread spectrum system.

# PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

## PCT

To:

Berggren Oy Ab  
P.O. Box 16  
FIN-00101 HELSINKI  
Finland

*SKU/MM*

WRITTEN OPINION *Berggren Oy Ab*  
(PCT Rule 66) 29 -06- 2001

Date of mailing **27 -06- 2001**  
(day/month/year)

Applicant's or agent's file reference  
**50242**

REPLY DUE within 60 days  
from the above date of mailing **25/8/01**

International application No.  
**PCT/FI00/00620**

International filing date (day/month/year)  
**06.07.2000**

Priority date (day/month/year)  
**09.07.1999**

International Patent Classification (IPC) or both national classification and IPC  
**H 04 B 7/06**

Applicant  
**Nokia Mobile Phones Ltd. et al**

1. This written opinion is the First (first, etc.) drawn by this International Preliminary Examining Authority.
2. This opinion contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

The applicant is hereby invited to reply to this opinion.

**When?** See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

**How?** By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

**Also** For an additional opportunity to submit amendments, see Rule 66.4.  
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4bis.  
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 09.11.2001

Name and mailing address of the IPEA/SE

Patent- och registreringsverket  
Box 5055  
S-102 42 STOCKHOLM  
Facsimile No. 08-667 72 88

Telex  
17978  
PATOREG-S

Authorized officer

Peder Gjervaldsaeter/MN  
Telephone No. 08-782 25 00

PCT Rec'd 04 JAN 2002

**I. Basis of the opinion**

**1. With regard to the elements of the international application:\***

☒ the international application as originally filed

☐ the description: \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the claims: \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, as amended (together with any statement) under article 19  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the drawings: \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the sequence listing part of the description: \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**  
These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:**

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

**4. ☐ The amendments have resulted in the cancellation of:**

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

**5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>2-11, 14-16</u>	YES
	Claims	<u>1, 12, 13</u>	NO
Inventive step (IS)	Claims	<u></u>	YES
	Claims	<u>1-16</u>	NO
Industrial applicability (IA)	Claims	<u>1-16</u>	YES
	Claims	<u></u>	NO

2. Citations and explanations

The claimed invention relates to transmission of a sequence of symbols using at least two antennas. According to the invention, the sequence is transmitted with a certain transmission pattern. A frame is transmitted by first transmitting the first symbol from a predefined antenna and then transmitting the rest of the symbols according to the transmission pattern, the transmission pattern starting from the beginning of each frame.

In the International Search Report the following documents were cited:

D1: IEEE 47<sup>th</sup> Vehicular Technology Conference 1997; Olofsson et al, "Transmitter diversity with antenna hopping.."

D2: IEEE, 49<sup>th</sup> Vehicular Technology Conference 1999, Raitola et al, "Transmission diversity in wideband CDMA"

D3: WO 9 608 908

In a complementary search this document was also found:

D4: WO 9 914 871

D1 describes a transmitter diversity system using antenna hopping. In D1 multiple antennas are used to transmit the signal according to a hopping pattern. Cyclic hopping, which evenly distributes the bursts of a speech frame on the available antennas, is used in D1. (See figure 1 and section III.)

D2 and D3 fail to describe the claimed invention.

D4 describes a space time block coding system. According to D4, a sequence of symbols is transmitted from two antennas in a transmission pattern determined by the space time block code. (See page 6, line 15-19 and claim 9.)

.../...

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

From D4 is already known a space time block coding transmitter, which transmits symbols in a sequence according to a transmission pattern. The space time block code determines itself the actual transmission pattern as is shown in table 1 (page 6). It is from table 1 clear that the transmission of the sequence is started by transmitting the first symbol (S0) from a predetermined antenna (Antenna 11). The whole transmission pattern (of course also including transmission of the first symbol) for the sequence is thus clearly indicated by the coding matrix of the space time block code. What is claimed in claims 1, 12 and 13 is therefore not novel considering what is known from D4.

more or  
less  
prior  
art  
0

From D1 is also already known a transmitter diversity system that evenly distributes symbols in a frame on a plurality of antennas according to a hopping pattern. It is considered obvious for a person skilled in the art that the hopping pattern in D1 has a predetermined starting antenna. Therefore, what is claimed in claims 1, 12 and 13 is not considered to involve an inventive step over what is already known from D1.

1107  
obvious

To repeat the transmission pattern until the end of the frame is considered obvious for a person skilled in the art and is not considered to involve an inventive step. Therefore, what is claimed in claim 2 fails to involve an inventive step.

What is claimed in claims 3-11 and 14-16 is considered to constitute details that are all considered obvious for a person skilled in the art. What is claimed in claims 3-11 and 14-16 is therefore not considered to involve an inventive step.

WRITTEN OPINION

International application No.

PCT/FI00/00620

VL Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No. _____	Publication date (day/month/year) _____	Filing date (day/month/year) _____	Priority date (valid claim) (day/month/year) _____
--	---	--	--

WCNC.1999, Rajan Dinesh et al "Transmit Diversity  
Schemes for CDMA-2000  
Publication data: 21-24 Sept, 1999

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure _____	Date of non-written disclosure (day/month/year) _____	Date of written disclosure referring to non-written disclosure (day/month/year) _____
---	---	--

REPLACES  
ART 34 AMDT

- the transmission pattern is started from the beginning in the beginning of each frame.

An arrangement according to the invention is an arrangement, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and

- starting means for starting the transmission pattern from the beginning in the beginning of a frame.

A network element according to the invention is a network element, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and

- starting means for starting the transmission pattern from the beginning in the beginning of a frame.

In a method according to the invention a sequence of symbol is transmitted using at least two antennas. The transmission of the symbols belonging to the sequence is characterized with a transmission pattern. Here the term transmission pattern refers to a pattern that specifies both from which antenna a symbol is transmitted and at which time the symbol is transmitted. The pattern may consist, for example, of a sequence of pattern items, and each of the pattern items corresponds to a certain period of time. A pattern item may be represented, for example, by a number indicating an antenna. For example, a pattern 1, 2, 0, 2, 2, 0, 1,..., where each number corresponds to a time slot, would indicate that a first symbol of the sequence is transmitted in a first time slot using a first antenna, a second symbol of the sequence is transmitted using a second antenna in a second time slot and in the third time slot no symbol belonging to the sequence is transmitted. In the fourth time slot, a third symbol of the sequence is transmitted using the second antenna, and so forth.

In the method according to the invention the antenna to transmit the first symbol belonging to the sequence is predefined. This means that a certain physical antenna is associated to the first antenna of the transmission pattern. The receiver thus

## Claims

1. A method (300, 400, 500) for transmitting a certain sequence of symbols, where
  - a frame is constructed of a certain number of consecutive symbols,
  - 5 - the symbols belonging to the sequence are transmitted (404, 502, 606) using at least two antennas and
  - the transmission of the sequence of symbols is characterized (401, 601) with a certain transmission pattern, characterized in that
  - the transmission of the sequence of symbols is started (402) from a predefined
  - 10 antenna and
  - the transmission pattern is started (403, 405) from the beginning in the beginning of each frame.
2. A method (500, 600) according to claim 1, where
  - the length of the transmission pattern is shorter than the length of a frame, and
  - 15 - the length of the frame is not a multiple of the length of the transmission pattern, characterized in that during each frame
  - the transmission pattern is repeated (502) until the length of the rest of the frame, which length is the length of the transmission pattern multiplied by the number of the repetition times within the frame subtracted from the length of the frame, is less
  - 20 than the length of the transmission pattern and
  - thereafter only a certain part, whose length is the length of the rest of the frame, of the transmission pattern is used (503).
3. A method according to claim 2, characterized in that the part of the transmission pattern is selected (609) from the beginning of the transmission pattern.
- 25 4. A method according to claim 2, characterized in that the length of the transmission pattern is an even number and the length of the frame is an odd number.
5. A method according to claim 4, where the sequence of symbols is transmitted using a first antenna and a second antenna, characterized in that the transmission pattern is an alternating pattern and the length of the transmission pattern is two.
- 30 6. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, characterized in that one symbol belonging to the sequence of symbols is transmitted in each time slot.



7. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, characterized in that at least one symbol belonging to the sequence of symbols is transmitted in each time slot.
- 5 8. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, characterized in that at least in one of the time slots at least one symbol belonging to the sequence of symbols is transmitted.
9. A method according to claim 1, characterized in that the length of the transmission pattern is larger than the length of the frame.
- 10 10. A method according to claim 1, characterized in that the transmission of the sequence of symbols is started from the primary antenna that transmits the common pilot signal.
11. A method according to claim 1, characterized in that the sequence of symbols is transmitted in downlink direction in a cellular network.
- 15 12. An arrangement (700), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, characterized in that it further comprises
- indication means (702) for indicating the antenna from which to transmit the first
  - 20 symbol belonging to the sequence and
  - starting means (703) for starting the transmission pattern from the beginning in the beginning of a frame.
13. A network element (710), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission
- 25 pattern and using at least two antennas, characterized in that it further comprises
- indication means (702) for indicating the antenna from which to transmit the first
  - symbol belonging to the sequence and
  - starting means (703) for starting the transmission pattern from the beginning in the beginning of a frame.
- 30 14. A network element according to claim 13, characterized in that it is a radio network controller of a spread spectrum system.

15. A network element according to claim 13, characterized in that it further comprises at least two antennas (721, 722).

16. A network element according to claim 15, characterized in that it is a base station of a spread spectrum system.

## PCT REQUEST

50242

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<b>0</b>	<b>For receiving Office use only</b>	
<b>0-1</b>	International Application No.	
<b>0-2</b>	International Filing Date	10/030286
<b>0-3</b>	Name of receiving Office and "PCT International Application"	
<b>0-4</b>	<b>Form - PCT/RO/101 PCT Request</b>	
<b>0-4-1</b>	Prepared using	PCT-EASY Version 2.90 (updated 10.05.2000)
<b>0-5</b>	<b>Petition</b> The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
<b>0-6</b>	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
<b>0-7</b>	Applicant's or agent's file reference	50242
<b>I</b>	<b>Title of invention</b>	METHOD FOR TRANSMITTING A SEQUENCE OF SYMBOLS
<b>II</b>	<b>Applicant</b>	
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50242

Original (for SUBMISSION) - printed on 06.07.2000 12:11:39 PM

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V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW MZ SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT

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50242


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V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW	
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	Exclusion(s) from precautionary designations	NONE	
VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	09 July 1999 (09.07.1999)	
VI-1-2	Number	991589	
VI-1-3	Country	FI	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	14	-
VIII-3	Claims	3	-
VIII-4	Abstract	1	50242.txt
VIII-5	Drawings	6	-
VIII-7	TOTAL	28	
VIII-8	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	Figure of the drawings which should accompany the abstract	4	
VIII-19	Language of filing of the international application	English	

## PCT REQUEST

50242

Original (for SUBMISSION) - printed on 06.07.2000 12:11:39 PM

IX-1	Signature of applicant or agent	
IX-1-1	Name	BERGGREN OY AB
IX-1-2	Name of signatory	Sirpa Kuisma
IX-1-3	Capacity	Patent Attorney

## FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

## FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
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**PCT (ANNEX - FEE CALCULATION SHEET)**

50242

Original (for SUBMISSION) - printed on 06.07.2000 12:11:39 PM

(This sheet is not part of and does not count as a sheet of the international application)

<b>0</b>	<b>For receiving Office use only</b>	
<b>0-1</b>	International Application No.	
<b>0-2</b>	Date stamp of the receiving Office	
<b>0-4</b>	<b>Form - PCT/RO/101 (Annex)</b>	
<b>0-4-1</b>	PCT Fee Calculation Sheet Prepared using	<b>PCT-EASY Version 2.90 (updated 10.05.2000)</b>
<b>0-9</b>	Applicant's or agent's file reference	<b>50242</b>
<b>2</b>	Applicant	<b>NOKIA MOBILE PHONES LTD., et al.</b>
<b>12</b>	<b>Calculation of prescribed fees</b>	<b>fee amount/multiplier      total amounts (FIM)</b>
<b>12-1</b>	Transmittal fee <b>T</b>	<b>⇒      800</b>
<b>12-2</b>	Search fee <b>S</b>	<b>⇒      5 618</b>
<b>12-3</b>	International fee Basic fee (first 30 sheets) <b>b1</b>	<b>2 431.8</b>
<b>12-4</b>	Remaining sheets	<b>0</b>
<b>12-5</b>	Additional amount <b>(X)</b>	<b>53.51</b>
<b>12-6</b>	Total additional amount <b>b2</b>	<b>0</b>
<b>12-7</b>	<b>b1 + b2 =      B</b>	<b>2 431.8</b>
<b>12-8</b>	Designation fees Number of designations contained in international application	<b>87</b>
<b>12-9</b>	Number of designation fees payable (maximum 8)	<b>8</b>
<b>12-10</b>	Amount of designation fee <b>(X)</b>	<b>523.22</b>
<b>12-11</b>	Total designation fees <b>D</b>	<b>4 185.76</b>
<b>12-12</b>	PCT-EASY fee reduction <b>R</b>	<b>-749.16</b>
<b>12-13</b>	Total International fee (B+D-R) <b>I</b>	<b>⇒      5 868.4</b>
<b>12-14</b>	Fee for priority document Number of priority documents requested	<b>1</b>
<b>12-15</b>	Fee per document <b>(X)</b>	<b>422</b>
<b>12-16</b>	Total priority document fee <b>P</b>	<b>⇒      422</b>
<b>12-17</b>	<b>TOTAL FEES PAYABLE (T+S+I+P)</b>	<b>⇒      12 708.4</b>
<b>12-19</b>	Mode of payment	<b>cheque</b>

**VALIDATION LOG AND REMARKS**

<b>13-2-3</b>	Validation messages Names	<b>Green?</b> <b>Applicant 1.:Telephone No. missing</b>
		<b>Green?</b> <b>Applicant 1.:Facsimile No. missing</b>

**PCT (ANNEX - FEE CALCULATION SHEET)**

50242

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13-2-6	Validation messages Contents	Green? Reference number for attached copy of general power of attorney not indicated.
13-2-7	Validation messages Fees	Green? Please confirm that fee schedule utilized is the latest available
		Green? Please verify that modified fee amounts are correct.



(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
18 January 2001 (18.01.2001)

PCT

(10) International Publication Number  
**WO 01/05061 A1**

(51) International Patent Classification<sup>7</sup>: **H04B 7/06**

(21) International Application Number: **PCT/FI00/00620**

(22) International Filing Date: **6 July 2000 (06.07.2000)**

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:  
991589 **9 July 1999 (09.07.1999) FI**

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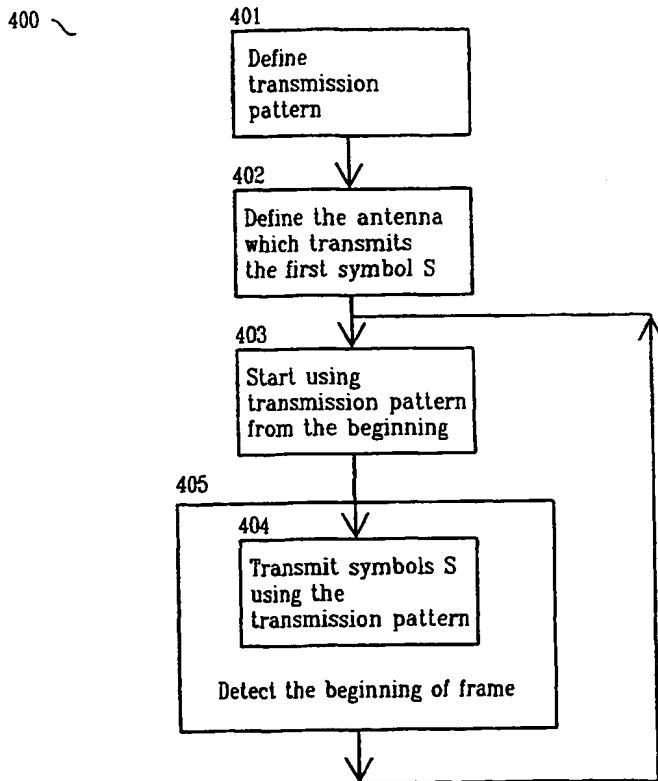
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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

[Continued on next page]

(54) Title: **METHOD FOR TRANSMITTING A SEQUENCE OF SYMBOLS**



(57) Abstract: The invention relates to a method (300, 400, 500) for transmitting a certain sequence of symbols, where a frame is constructed of a certain number of consecutive symbols, the symbols belonging to the sequence are transmitted (404, 502, 606) using at least two antennas and the transmission of the sequence of symbols is characterized (401, 601) with a certain transmission pattern. The method according to the invention is characterized in that the transmission of the sequence of symbols is started (402) from a predefined antenna and the transmission pattern is started (403, 405) from the beginning in the beginning of each frame. The invention also relates to an arrangement (700) and to a network element (710) for controlling the transmission of a sequence of symbols.

WO 01/05061 A1



patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

— Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

**Published:**

— With international search report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

## Method for transmitting a sequence of symbols

The invention relates in general to transmission of a certain sequence of symbols. In particular the invention relates to diversity transmissions where the symbols  
5 belonging to the sequence are sent using at least two antennas.

In cellular networks the downlink and uplink radio transmissions comprise synchronization channels, which can be special synchronization symbols. Using the information carried in the synchronization symbols, for example, the receiver can  
10 determined the timing of the transmission. Information is usually sent in frames, and the frames consist of a certain number of time slots. The time slots, in turn, consist of a certain number of symbols. If synchronization symbols are used, they can be sent, for example, once in each time slot. It is also possible to send synchronization information in bursts, so that more information is sent at a time, but synchronization  
15 information is sent less frequently than once in a time slot. From the synchronization information it is possible to determine both the time slot timing and the frame timing, i.e. where time slots and frames start.

The synchronization symbols may carry also other information than just indicate timing. For example, in Wideband Code Division Multiple Access (WCDMA) cellular networks the synchronization symbols carry certain information about the  
20 spreading code that a base station uses to spread the downlink transmissions. In a handover, for example, the mobile station entering a new cell can determine the part of the downlink spreading code with the help of the synchronization symbols. The mobile station needs to know the spreading code in order to find out the control information transmitted via the common control channel. Otherwise it cannot, for  
25 example, communicate with the radio access network after power up or in a handover situation receive from the new cell cell-specific control information that is needed to perform the handover.

Traditionally information is transmitted over radiolink using a single antenna. Transmission diversity refers to sending information via more than one antennas.  
30 The transmitted information can be, for example, encoded so that the transmitted symbol flows are not equal, but the original information flow can be determined from each transmitted symbol flow. The receiver can, for example, choose special decoding scheme in case transmission diversity is used and deduce the transmitted information. The synchronization symbols can carry information also about the use

of some transmission diversity scheme. It is important that the receiver can determine the sent synchronization symbol correctly. Otherwise, for example, it may fail to identify the transmission diversity and encoding schemes that are used.

Fig. 1 represents a typical WCDMA cell 100, where there is a base station 101 in the middle of the cell. There are also two mobile stations 102 and 103 in the Fig. 1, and the communication between each mobile station and the base station is indicated with arrows. The base station broadcasts common control information to all the mobile stations in the cell, and it spreads this common control information with a certain spreading code. In a WCDMA system, a spreading code usually consists of two parts: a long scrambling code  $C_s$  and a short channelization code  $C_c$ . The scrambling code is effective to eliminate, for example, the effect of multipath propagation. The channelization codes that are used within a cell are orthogonal, and they are effective to distinct, for example the transmission to each mobile station. In a WCDMA system, within a cell a same scrambling code  $C_s$  may be used for all downlink transmissions. The downlink transmission are synchronized, and therefore the different channelization codes are enough for successful despreading of the transmitted signals. In the neighboring cells, other scrambling codes are used so that adjacent cells do not disturb each other's transmissions.

The use of spreading codes in downlink transmission is presented in Fig. 1, where the arrow 111 represents the common control information broadcast. The spreading code can be presented as the product of the scrambling and channelization codes  $C_{CC} = C_s C_c$ . When entering a new cell, the mobile station can determine the downlink scrambling code  $C_s$  from the broadcast transmission the base station sends. The channelization code related to common control information is typically a fixed constant throughout the WCDMA system, so after determining the downlink scrambling code and the frame timing, the mobile station can determine the common control information.

The arrow 112 in Fig. 1 represents the downlink transmission to the mobile station 102, and the arrow 113 represents the downlink transmission to the mobile station 103. The spreading code  $C_{D1}$  for the downlink connection to the mobile station 102 is  $C_{D1} = C_s C_{c1}$ , and the spreading code  $C_{D2}$  for the downlink connection to the mobile station 103 is  $C_{D2} = C_s C_{c2}$ . Since the uplink transmissions are not synchronized and each mobile has its own radio channel from the mobile station to the base station, each mobile station may use a specific scrambling code, and various channels, for example, to a certain mobile station may be separated using various channelization codes. The downlink and uplink spreading codes for

connections terminating to a mobile station are usually established either when a mobile station enters a new cell or when a new connection is established between the mobile station and the radio access network.

Fig. 2 shows some of the common channels a base station in a WCDMA system generally transmits. The pilot symbols are transmitted over a common pilot channel (CPICH) 201. The pilot symbols are usually sent 100% of the duty cycle. The pilot symbols are predetermined, and CPICH is spread using the downlink scrambling code  $C_s$  and a fixed channelization code.

The synchronization channel (SCH) 202 occupies typically 10% of the duty cycle in the beginning of each time slot 210. The frame 211, which comprises a certain fixed number of time slots, is also presented in Fig. 2. The synchronization channel carries two synchronization codes: a primary synchronization code 203 and a secondary synchronization code 204. These codes are transmitted simultaneously within one symbol period. Both the primary and secondary synchronization codes can be modulated, for example, with the same symbol, and because the codes have good crosscorrelation properties the receiver can distinguish the codes. A mobile station entering a new cell or measuring a new cell in the neighborhood may always receive successfully information broadcast over the SCH.

The primary synchronization code is a constant code that denotes the beginning of the time slots. The secondary synchronization codes, which form a synchronization code sequence or word, indicate the timing of the frames. In addition to the frame timing, the second synchronization code sequence within a frame indicates the scrambling code group to which the downlink scrambling code the base station uses belongs. A mobile station entering a new cell may determine the downlink scrambling code, for example, by testing the scrambling codes of the indicated scrambling code group on the CPICH. The correct scrambling code  $C_s$  is the one that with the known channelization code produces from the received radio signal the known transmitted pilot symbols.

Once the scrambling code  $C_s$  has been determined, the received pilot symbols may be used, for example, for determining the complex channel coefficient. In general, the radio signal that is received is not exactly the same as the transmitted one. The signal may experience changes in amplitude and phase, and these changes are time-dependent. They are taken into account using the complex channel coefficient  $h$  when the despread signal is processed. An estimate  $\hat{h}$  for the channel coefficient can be determined by comparing the received pilot symbols to the known trans-

mitted pilot symbols. The channel coefficient may be assumed to be constant during the time over which the pilot symbol and the studied symbol are transmitted.

Common control information is transmitted using, for example, a Primary Common Control Physical Channel (PCCPCH) 205. PCCPCH is transmitted 90% of the duty cycle, at the time when the synchronization symbols are not sent. It is spread using a predetermined channelization code and the downlink scrambling code, as discussed above. After the scrambling code has been identified, the mobile station may despread the CCPCCH information from the spread signal it receives. The information may be, for example, information related to the logical Broadcast Control Channel (BCCH). The mobile station needs the BCCH information, for example, to start communicating with the radio access network after power up or to make a successful handover.

Fig. 2 represents a situation where the base station uses only one antenna TX1 for broadcasting information. When transmission diversity is employed, there are at least two antennas where the information may be transmitted. It is preferable that each antenna transmits its own pilot signal, so that the channel coefficient estimates can be determined for each antenna. The radio waves emitted for the two transceivers may propagate in different ways to the antenna of the mobile station.

Fig. 3 represents some broadcast channels when transmission diversity and two antennas TX1 and TX2 are in use. The antenna TX1 transmits the common pilot channel CPICH 201 similarly as when no transmission diversity is employed. The antenna TX2 transmits an auxiliary pilot 301. The synchronization symbols may be transmitted using only one antenna or both antennas. In time switched transmit diversity (TSTD) both antennas are used to transmit the symbols, one at a time. Fig. 3 shows how the synchronization symbols are transmitted using TSTD and an alternating transmission pattern. For example, the synchronization symbol 302 is transmitted from the antenna TX1 and the synchronization symbol 303 is transmitted from the antenna TX2. Each synchronization symbol carries both the primary and the secondary synchronization code.

The common control information may be also transmitted from both antennas TX1 and TX2. In this case the BCCH information, for example, is encoded before it is transmitted over the PCCPCH channel. Space time transmit diversity (STTD), for example, specifies that from the primary antenna TX1 the symbols are transmitted as such, i.e. the sequence of transmitted symbols is  $S_1, S_2, S_3, S_4, \dots$ . From the second antenna TX2 the sequence of transmitted symbols starts in the following

way:  $-S_2^*$ ,  $S_1^*$ ,  $-S_4^*$ ,  $S_3^*$ , ..., where the asterisk indicates the complex conjugate. Fig. 3 presents the PCCPCH data 304 transmitted from the antenna TX1 and the PCCPCH data 305 transmitted from the antenna TX2. It is possible also to use the space time transmit diversity for the BCCH information but transmit all the synchronization symbols from one antenna.

The base station may indicate the use of diversity scheme and two transceivers, for example, by transmitting a specific message on a broadcast channel or modulating the synchronization symbols. A certain synchronization symbol value indicates that the STTD is on, and another value indicates that it is off. The mobile station may also determine the use of a diversity scheme by detecting the auxiliary pilot symbols. The mobile station may also use all three indicators of the diversity scheme.

When the mobile station detects the presence of STTD using the synchronization symbol, the value of the synchronization symbol needs to be determined reliably. When a certain symbol needs to be determined, the effect of the channel coefficient has to be taken into account. The mobile station receives the following signal  $r$

$$r = h s_{\text{SCH}} + n$$

where  $h$  represents the complex channel coefficient,  $s_{\text{SCH}}$  represents the synchronization symbol and  $n$  represent the noise.

When the received signal  $r$  is multiplied by the complex conjugate of the channel coefficient estimate  $\hat{h}^*$

$$\hat{h}^* r = \hat{h}^* (h s_{\text{SCH}} + n) = \hat{h}^* h s_{\text{SCH}} + \hat{h}^* n$$

the result is the synchronization symbol scaled with a scalar  $\hat{h}^* h$  and the term related to noise. From here it is quite straightforward to infer the value of the synchronization symbol.

Above, the synchronization symbols have been used as an example of a sequence of symbols that is transmitted using two antennas. The problem is that when the TSTD diversity scheme is in use, the mobile station cannot necessarily distinguish from which antenna a certain synchronization symbol, or any other symbol that is transmitted using a time switched diversity scheme, is transmitted. Consider, for example, a situation where a certain sequence of symbols is transmitted once is every time slot, and a frame consists of an odd number of time slots. If the symbols

belonging to the sequence are transmitted using a time switched diversity scheme, two diversity antennas are used and the transmission pattern is an alternating pattern, in a certain time slot the symbol belonging to the sequence is transmitted from one antenna in every other frame and in the rest of the frames from the other antenna. Therefore the mobile station does not know, which channel coefficient estimate to use for a symbol sent in a certain time slot with a time switched transmission scheme.

To obtain a reliable result, the signal transmitted by the primary transceiver has to be processed with the channel coefficient estimate  $\hat{h}_2$  determined from the primary pilot and the signal transmitted by the secondary transceiver has to be processed with the channel coefficient estimate  $\hat{h}_2$  determined from the auxiliary pilot. Not knowing from which antenna a certain symbol is transmitted causes unnecessary interference to the decision which symbol was sent. In case of synchronization symbols, this may cause that the mobile station cannot utilize the transmission diversity of, for example, the common control information for enhancing the quality of the received signal. Consequently, if the transmission diversity is in use, but the receiver does not notice this, the quality of the received common control signal may be poorer than in a case where no transmission diversity is applied.

The object of the invention is to provide a versatile method for transmitting a sequence of symbols using at least two antennas. A further object of the invention is that the method enables to determine unambiguously from which antenna a symbol belonging to sequence is transmitted.

The objects of the invention are achieved by starting the time switched transmit diversity pattern of the sequence of symbols always from the same antenna in the beginning of a frame and by using the same pattern in each frame.

A method according to the invention is a method for transmitting a certain sequence of symbols, where

- a frame is constructed of a certain number of consecutive symbols,
- the symbols belonging to the sequence are transmitted using at least two antennas and
- the transmission of the sequence of symbols is characterized with a certain transmission pattern, and it is characterized in that
- the transmission of the sequence of symbols is started from a predefined antenna and



- the transmission pattern is started from the beginning in the beginning of each frame.

An arrangement according to the invention is an arrangement, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and

- starting means for starting the transmission pattern from the beginning in the beginning of a frame.

A network element according to the invention is a network element, which comprises control means for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, and it is characterized in that it further comprises

- indication means for indicating the antenna from which to transmit the first symbol belonging to the sequence and

- starting means for starting the transmission pattern from the beginning in the beginning of a frame.

In a method according to the invention a sequence of symbol is transmitted using at least two antennas. The transmission of the symbols belonging to the sequence is characterized with a transmission pattern. Here the term transmission pattern refers to a pattern that specifies both from which antenna a symbol is transmitted and at which time the symbol is transmitted. The pattern may consist, for example, of a sequence of pattern items, and each of the pattern items corresponds to a certain period of time. A pattern item may be represented, for example, by a number indicating an antenna. For example, a pattern 1, 2, 0, 2, 2, 0, 1,..., where each number corresponds to a time slot, would indicate that a first symbol of the sequence is transmitted in a first time slot using a first antenna, a second symbol of the sequence is transmitted using a second antenna in a second time slot and in the third time slot no symbol belonging to the sequence is transmitted. In the fourth time slot, a third symbol of the sequence is transmitted using the second antenna, and so forth.

In the method according to the invention the antenna to transmit the first symbol belonging to the sequence is predefined. This means that a certain physical antenna is associated to the first antenna of the transmission pattern. The receiver thus

knows which of the pilot signals is transmitted by the same antenna as the first symbols of the sequence, and it may use the correct channel coefficient estimate in processing the first symbol of the sequence. If, for example, the first symbol of the sequence is transmitted using the primary antenna that transmits the common pilot, the channel coefficient estimate determined from the common pilot is used to process the received first symbol.

Further, in the method according to the invention, the transmission pattern is started from the beginning in the beginning of each frame. Even if the receiver starts to receive the signal in the middle of the transmission, it knows explicitly that in each frame the first symbol belonging to the sequence is transmitted using a predefined antenna, for example, the primary antenna.

The advantage of the method according to the invention is thus that the receiver knows for certain at least the antenna from which in each frame the first symbol belonging to the symbol sequence is transmitted. It may thus process at least these symbols with the correct channel coefficient estimate. This removes unnecessary interference in the decision process where the received symbol is determined. When the method according to the invention is in use, at least some of the symbols of the sequence can thus be received reliably.

Usually the receiver knows the transmission pattern, and if two antennas are used to transmit the symbol sequence, the information from which antenna the first symbol in each frame is transmitted reveals the transmission antennas of all the symbols in that frame. A further advantage of the invention is thus that in a case where two diversity antennas are used and the receiver knows the transmission pattern, the receiver can process all received symbols belonging to the sequence with correct channel coefficient estimations and determine the received symbols reliably.

If more than two diversity antennas are in use, the method according to the invention can be applied, too. If  $n$  diversity antennas are in use and at least  $n-1$  antennas in the transmission pattern are associated to physical antennas, then a receiver who knows the transmission pattern, can use correct channel coefficient estimation for all the received symbols belonging to the sequence and determine their values reliably.

The invention will now be described more in detail with reference to the preferred embodiments by the way of example and to the accompanying drawings where

- Fig. 1 shows a schematic drawing of a base station communicating with two mobile terminals in WCDMA system,
- Fig. 2 shows a schematic drawing of some of the common broadcast channels in WCDMA system,
- 5 Fig. 3 shows a schematic drawing of some of the common broadcast channels in WCDMA system when transmission diversity is in use,
- Fig. 4 shows a flowchart of method according to a first preferred embodiment of the invention,
- 10 Fig. 5 shows a flowchart of method according to a second preferred embodiment of the invention,
- Fig. 6 shows a flowchart of a method according to a third preferred embodiment of the invention and
- Fig. 7 shows a schematic drawing of a network element and an arrangement that employ a method according to the invention.
- 15 Above in conjunction with the description of the prior art reference was made to Figs. 1-3. The same reference numerals are used for corresponding parts in the figures.
- Fig. 4 shows a flowchart of a method 400 according to a first embodiment of the invention. A sequence of symbols is transmitted using a specified transmission  
20 pattern. The symbols belonging to the sequence are marked with *S*. In step 401 the transmission pattern that characterizes the transmission of a certain sequence of symbols is defined. In step 402 the antenna which transmits the first symbol *S* of the sequence is defined. Thereafter the actual transmission of symbols *S* belonging to the sequence begins.
- 25 In step 403 the transmission pattern is reset, so that the next symbol *S* of the sequence is transmitted according to the first item of the transmission pattern. In step 404 symbols of the sequence are transmitted according to the transmission pattern. Step 405 is carried out simultaneously with the transmission in step 404, and when the beginning of a new frame is detected in step 405, the transmission  
30 pattern is reset in step 403 and the next symbol *S* of the sequence is transmitted as the first item of the transmission pattern specifies.

Because the transmission pattern specifies the time at which the symbols  $S$  are sent, the length of the transmission pattern can be measured in units of time. The length of the transmission pattern can be expressed, for example, in time slots. If the transmission pattern is longer than a frame, then in a method according to this first preferred embodiment of the invention only a certain number (corresponding to the length of a frame) of items in the beginning of the transmission pattern is used. If the transmission is shorter than a frame, then symbols  $S$  are transmitted only in the first part of the frame in a method according to the first preferred embodiment of the invention.

- 10 In a method according to the first embodiment of the invention, in each frame a same number of symbols  $S$  is transmitted. The first of these symbols  $S$  within a frame is always sent using the predefined antenna. In fact, each of the symbols  $S$  within a frame in the consecutive frames are transmitted using a certain antenna. The symbols  $S$  are thus transmitted similarly in each frame (although the values of the symbols, for example in certain time slots in consecutive frames, need not be same).

- Fig. 5 shows a flowchart of a method 500 according to a second preferred embodiment of the invention. In this method, if the length of the transmission pattern is shorter than a frame, the transmission pattern is repeated in a certain way. This ensures that the symbols  $S$  of the sequence are transmitted during the whole frame.

- The method 500 begins similarly as the method 400 according to the first preferred embodiment of the invention. In step 401 the transmission pattern is defined and in step 402 the antenna which transmits the first symbol  $S$  of the sequence. In step 403 the transmission pattern is started from the beginning.

- In step 501 it is checked, if the length of the rest of the frame is longer than or equal to a complete transmission pattern. If it is, then in step 502 symbols  $S$  are transmitted using the complete transmission pattern, and thereafter the length of the rest of the frame is checked again. In this method, the transmission pattern is thus repeated during a frame as many times as it can be repeated completely.

When the end of the frame is near, i.e. the length of the rest of the frame is less than the length of the transmission pattern, then in step 503 symbols  $S$  are transmitted using only a certain part of the transmission pattern. The length of this part is equal to the remainder of the length of a frame divided by the length of the transmission

pattern. Thereafter the transmission pattern is started from the beginning in step 403, and symbols  $S$  are again transmitted using the complete transmission pattern in step 502. The part of the transmission pattern can be selected, for example, from the beginning of the pattern.

- 5 The advantage of this method according to the second preferred embodiment of the invention is that even if the transmission pattern is shorter than a frame and the length of a frame is not a multiple of the transmission pattern, it is possible to transmit symbols  $S$  of the sequence throughout a frame by repeating the transmission pattern and be certain that in each frame the symbols  $S$  of the sequence are  
10 transmitted using the diversity antennas similarly.

This method works also if the length of the transmission pattern is longer than the frame. In that case step 502 is never entered, and only a certain part of the transmission pattern is used in sequential steps 503.

- 15 Fig. 6 shows a more detailed flowchart of a transmission method 600 according to a third preferred embodiment of the invention. In this method, the diversity antenna that transmits the first symbol of the sequence is also specified, although this is not shown in Fig. 6. In this method, if the transmission pattern is short, it is repeated within a frame similarly as in method 500. The part of the transmission pattern, which is placed to the end of each frame, is selected here from the beginning of the  
20 transmission pattern.

- In step 601 the transmission pattern is defined. In step 602 the length of the frame and the length of the transmission pattern are determined. In the method, the index  $j$  is used to denote the items of the transmission pattern, and in step 603 the active indexes for each antenna are determined from the transmission pattern. An active  
25 index refers here to those transmission pattern items during which a symbol  $S$  is transmitted using a certain antenna. Consider on example, where transmission pattern is a simple alternating pattern and two diversity antennas are used. If one symbol  $S$  is transmitted, for example, in the beginning of each time slot, then the transmission pattern items correspond to a time slot. The transmission pattern can be  
30 represented, for example, with two numbers 1 and 2. The odd values of  $j$  are active for one antenna and the even values of  $j$  for the other antenna. If in a certain time slot of a pattern no symbol  $S$  is transmitted, then the respective value of  $j$  is not active for any antenna. Similarly, if in a certain time slot of a pattern both antennas are transmitting a symbol  $S$ , then the respective value of  $j$  is active for both  
35 antennas.

Index  $j$  runs from 1 to the length of the transmission pattern. The length of the transmission pattern may be expressed, for example, in symbols or in time slots.

5 In step 604 the value of index  $j$  is initialized to one. In the same step 604 index  $i$ , which refers to time units of a frame, is also initialized to one. Index  $i$  has to refer to a same time unit as index  $j$ . If  $n > 1$  symbols  $S$  can be transmitted in each time slot, then the index  $i$  may run, for example, from 1 to  $n$  times the number of time slots in a frame. In this case, the length of the transmission pattern would also be expressed in  $n$ 'th parts of a time slot.

10 In step 605 it is checked, if the current value of  $j$  is active, i.e. if any of the diversity antennas is expected to transmit a symbol  $S$  in the current time unit. If  $j$  is active, then in step 606 the antenna(s) specified by the transmission pattern transmits the symbol  $S$ . After transmission, in step 607 it is checked, if the end of frame or end of pattern has been reached. If  $j$  is not active, then this checking is done directly after step 605. If either the end of frame or the end of the pattern has been reached, then  
15 the transmission pattern is started afresh by initializing  $j$  to 1 in step 609. If the current time unit is in the middle of the frame and the end of the pattern is not reached, then index  $j$  is pointed to the next item in the transmission pattern. This takes place in step 608, where  $j$  is increased by one.

20 After index  $j$  has been updated in either step 608 or 609, in step 610 it is checked, if the end of the frame has been reached, i.e. if index  $i$  has reached its maximum value. If the end of the frame has been reached, then in step 612 index  $i$  is initialized to one. If the current time slot is in the middle of the frame, then index  $i$  is pointed to the next time unit by increasing it by one in step 611. After the value of index  $i$  has been updated, it is checked in step 605 if the current item of the transmission  
25 pattern is active.

As an example, consider a simple pattern whose length is two time slots and, for example, a synchronization symbol is transmitted once in a time slot. Index  $j$  thus has values 1 and 2. Further, consider that the pattern is alternating. The values 1 and 2 of index  $j$  may thus directly indicate the diversity antenna using which the  
30 synchronization symbol is transmitted. Using the term active index, this can be expressed by saying that, for example, for the primary diversity antenna the index value 1 is active, and for the auxiliary diversity antenna, the index value 2 is active.

If the length of the frame is  $m$  time slots, and  $m$  is an odd number, then as long as  $i < m$ , steps 608 and 609 are carried out in an alternating manner and the

synchronization symbols are transmitted from the two diversity antennas in an alternating manner. The pairs  $(i, j)$  in the consecutive transmission steps 606 are  $(1, 1), (2, 2), (3, 1), (4, 2), \dots, (m-2, 1), (m-1, 2)$ .

When index  $i$  is increased to value  $m$  in step 611, the pair  $(i, j)$  has value  $(m, 1)$  next time in step 606. Thereafter the check in step 607 results the initialization of  $j$ , because  $i = m$  indicates the end of the frame. In the consecutive step 612 index  $i$  is initialized, and the next time the transmission step 606 is entered, the value of the pair  $(i, j)$  is  $(1, 1)$ . The transmission pattern is thus started afresh, when a new frame is started.

10 If the transmission pattern is, for some reason, defined to be longer than the frame, steps 607 and 609 take care also in this case that the transmission pattern is started afresh when a frame starts. The end of the transmission pattern is not used.

Fig. 7 shows a network element and an arrangement which employ a method according to the invention when they control the transmit of a certain sequence of symbols. The arrangement 700 for controlling the transmission of synchronization symbols comprises a control block 701, which controls the actual transmission of symbols  $S$  according to a transmission pattern. It chooses the diversity antenna for each symbol  $S$ . The transmission pattern is generated in a generation block 705 and the sequence of symbols  $S$  may be generated in the symbol block 704, which is not part of the arrangement 700.

The arrangement 700 comprises also an indication block 702, which is responsible for indicating the antenna using which the first symbol  $S$  of the sequence is transmitted. It also comprises a starting block 703, which, for example, detects the beginning of a frame, and starts the generation of the transmission pattern again from the beginning. The arrangement 700 may use any transmission method according to the invention. The block 701-705 may be implemented using, for example, microcontrollers and suitable program code.

The control arrangement can be implemented in the same network element which is responsible for transmitting the sequence of symbols. Fig. 7 shows a network element 710 which in addition to the arrangement 700 comprises two antennas 721 and 722. The arrangement controls the transmission of the symbols  $S$ , and the actual transmission is done using the antennas. The network element 710 presented in Fig. 7 may be, for example, a base station of the WCDMA system.

It is also possible to control the transmission of a certain sequence of symbols in another network element than in the one that transmits the symbols. The arrangement 700 can be a part of, for example, the Radio Network Controller (RNC) of the WCDMA system.

- 5 While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various other embodiments of the invention will be apparent to persons skilled in the art upon reference to this description. It is therefore contemplated that the appended claims will cover any such modifications of the embodiments as fall within the true scope  
10 and spirit of the invention.

The WCDMA system has been presented as an example of a cellular network where a method according to the invention can be applied. It does not restrict the use of a method according to the invention to WCDMA networks.

- 15 Frames and time slots have been used here as examples of the hierarchical structures using which information is transmitted over a radiolink. The names of these structures may vary from system to system and a method according to the invention can be applied in any system where information is transmitted over radiolink in hierarchical structures.

- 20 The method according to the invention can be used to transmit any sequence of symbols. The invention does not restrict the type or values of the symbols that are transmitted using a method according to the invention. The sequence may contain, for example, only symbols of one value, as the synchronization symbols in WCDMA system. The sequence may also be, for example, a periodic sequence, where certain symbols are repeated. The length of the period does not have to be  
25 any multiple of the pattern length, nor the pattern length need to be any multiple of the sequence period.



**Claims**

1. A method (300, 400, 500) for transmitting a certain sequence of symbols, where
  - a frame is constructed of a certain number of consecutive symbols,
  - 5 - the symbols belonging to the sequence are transmitted (404, 502, 606) using at least two antennas and
  - the transmission of the sequence of symbols is characterized (401, 601) with a certain transmission pattern, characterized in that
  - the transmission of the sequence of symbols is started (402) from a predefined
  - 10 antenna and
  - the transmission pattern is started (403, 405) from the beginning in the beginning of each frame.
2. A method (500, 600) according to claim 1, where
  - the length of the transmission pattern is shorter than the length of a frame, and
  - 15 - the length of the frame is not a multiple of the length of the transmission pattern, characterized in that during each frame
  - the transmission pattern is repeated (502) until the length of the rest of the frame, which length is the length of the transmission pattern multiplied by the number of the repetition times within the frame subtracted from the length of the frame, is less
  - 20 than the length of the transmission pattern and
  - thereafter only a certain part, whose length is the length of the rest of the frame, of the transmission pattern is used (503).
3. A method according to claim 2, characterized in that the part of the transmission pattern is selected (609) from the beginning of the transmission pattern.
- 25 4. A method according to claim 2, characterized in that the length of the transmission pattern is an even number and the length of the frame is an odd number.
5. A method according to claim 4, where the sequence of symbols is transmitted using a first antenna and a second antenna, characterized in that the transmission pattern is an alternating pattern and the length of the transmission pattern is two.
- 30 6. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, characterized in that one symbol belonging to the sequence of symbols is transmitted in each time slot.

7. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, characterized in that at least one symbol belonging to the sequence of symbols is transmitted in each time slot.
- 5 8. A method according to claim 1, where each frame consists of a certain number of consecutive time slots and each time slot consists of a certain number of consecutive symbols, characterized in that at least in one of the time slots at least one symbol belonging to the sequence of symbols is transmitted.
9. A method according to claim 1, characterized in that the length of the transmission pattern is larger than the length of the frame.
- 10 10. A method according to claim 1, characterized in that the transmission of the sequence of symbols is started from the primary antenna that transmits the common pilot signal.
11. A method according to claim 1, characterized in that the sequence of symbols is transmitted in downlink direction in a cellular network.
- 15 12. An arrangement (700), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission pattern and using at least two antennas, characterized in that it further comprises
- indication means (702) for indicating the antenna from which to transmit the first
  - 20 symbol belonging to the sequence and
  - starting means (703) for starting the transmission pattern from the beginning in the beginning of a frame.
13. A network element (710), which comprises control means (701) for controlling the transmission of a sequence of symbols according to a certain transmission
- 25 pattern and using at least two antennas, characterized in that it further comprises
- indication means (702) for indicating the antenna from which to transmit the first
  - symbol belonging to the sequence and
  - starting means (703) for starting the transmission pattern from the beginning in the beginning of a frame.
- 30 14. A network element according to claim 13, characterized in that it is a radio network controller of a spread spectrum system.

15. A network element according to claim 13, characterized in that it further comprises at least two antennas (721, 722).

16. A network element according to claim 15, characterized in that it is a base station of a spread spectrum system.

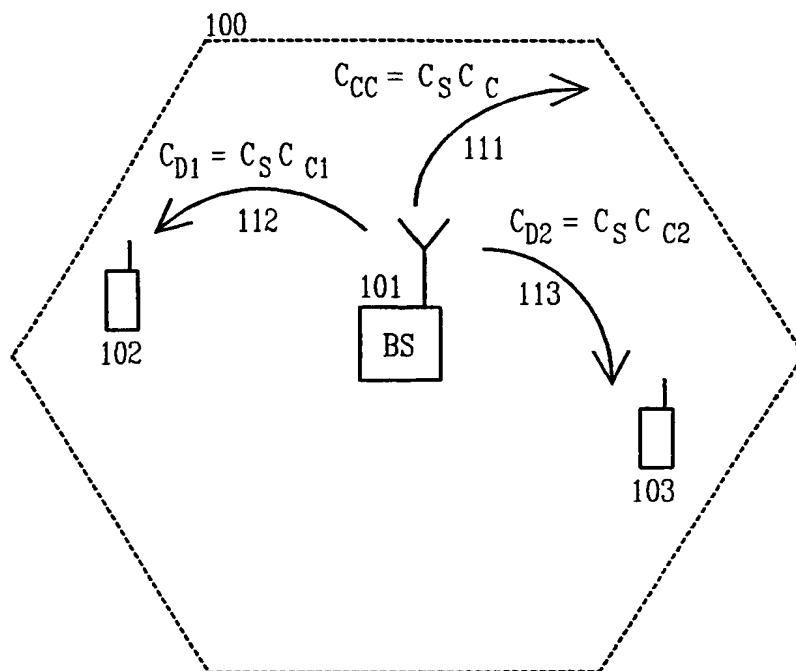


FIG. 1 PRIOR ART

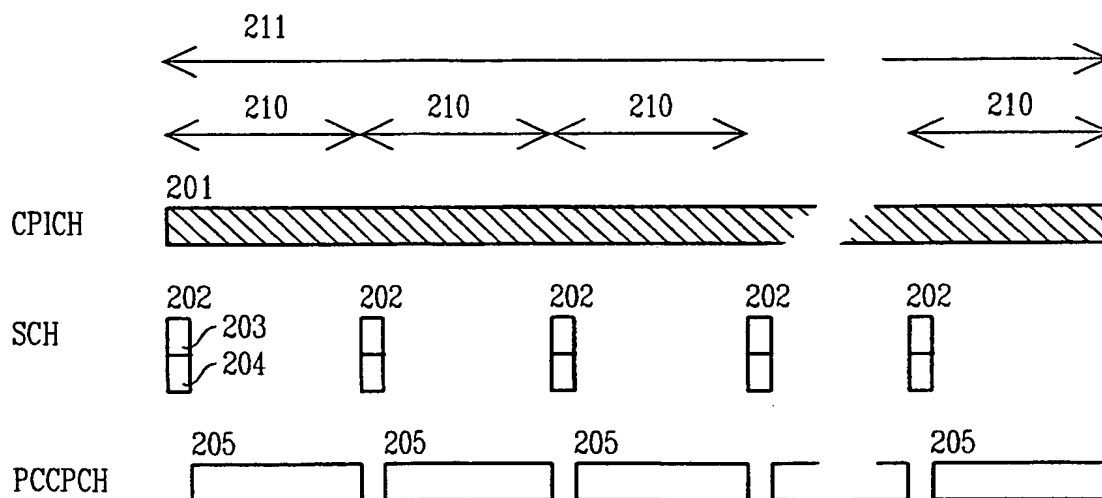


FIG. 2 PRIOR ART

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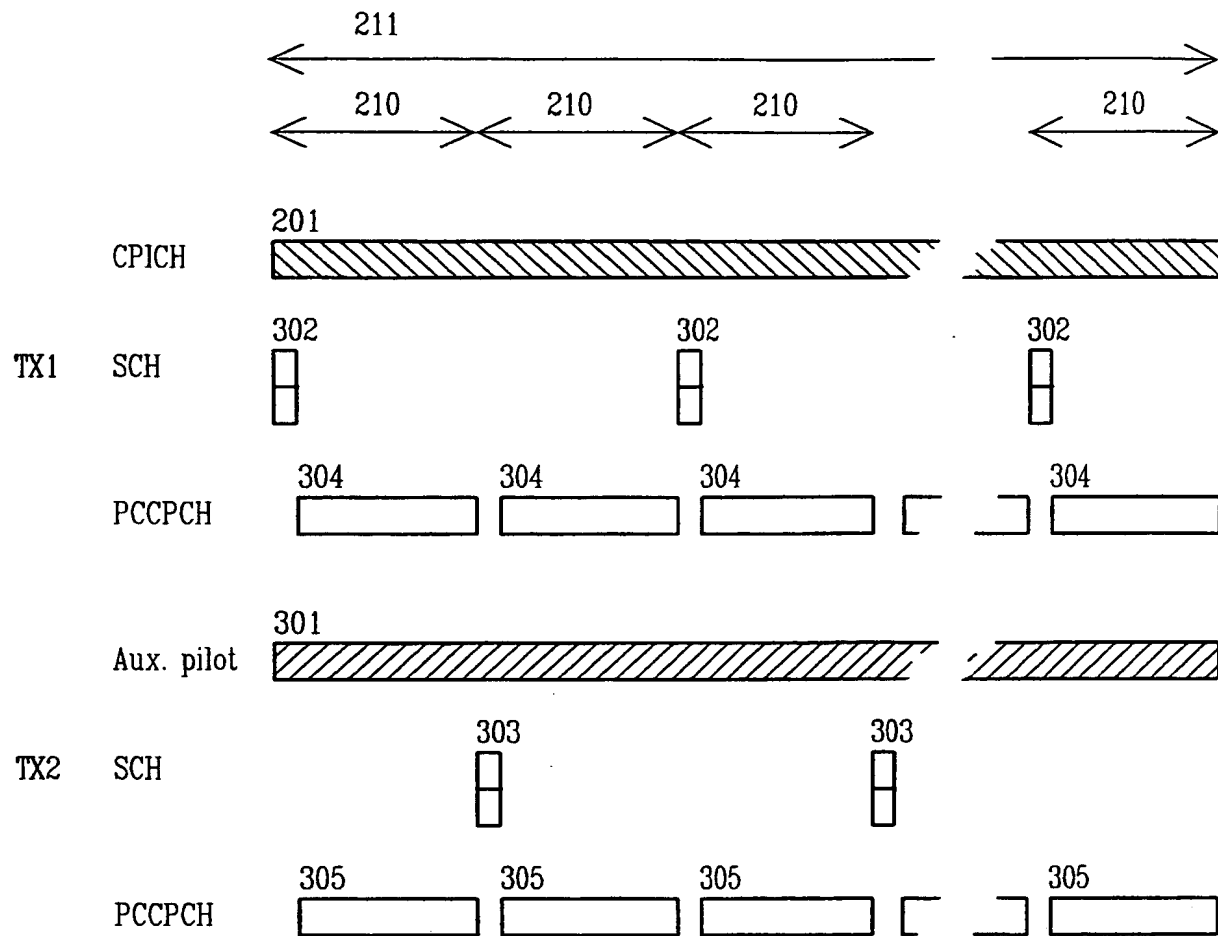


FIG. 3 PRIOR ART

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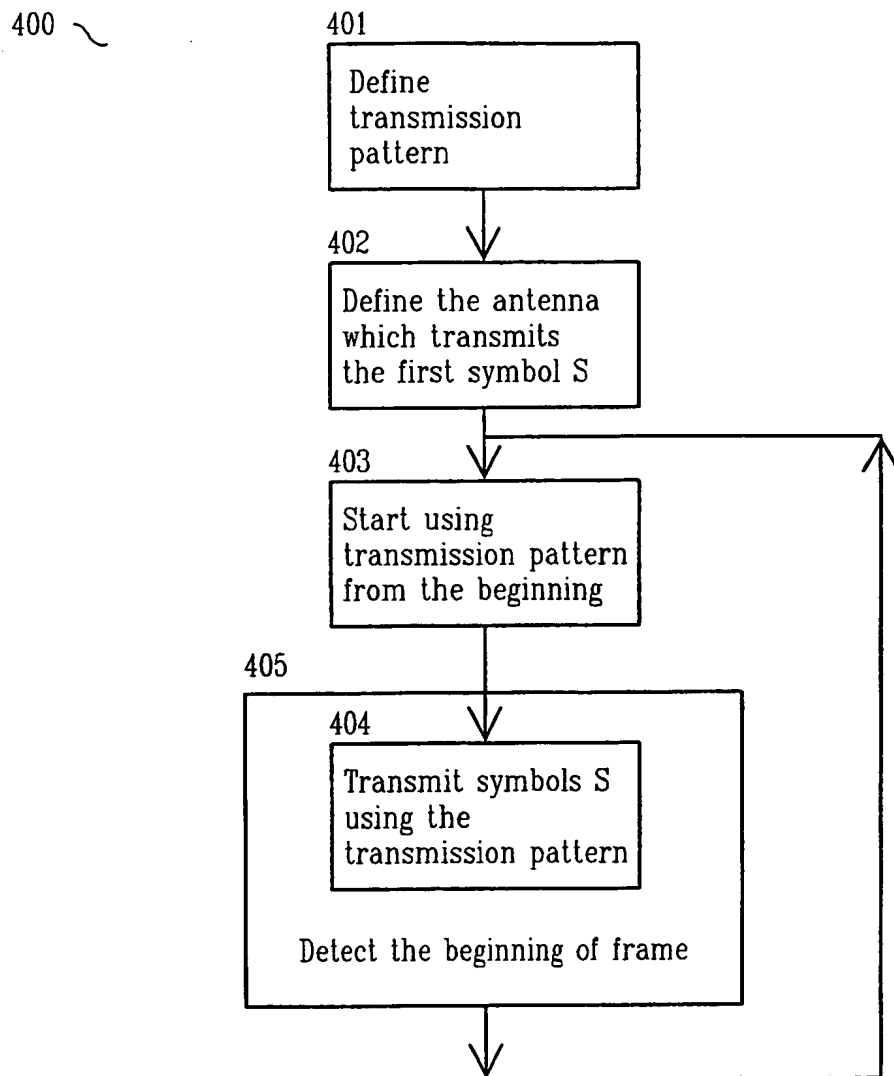


FIG. 4

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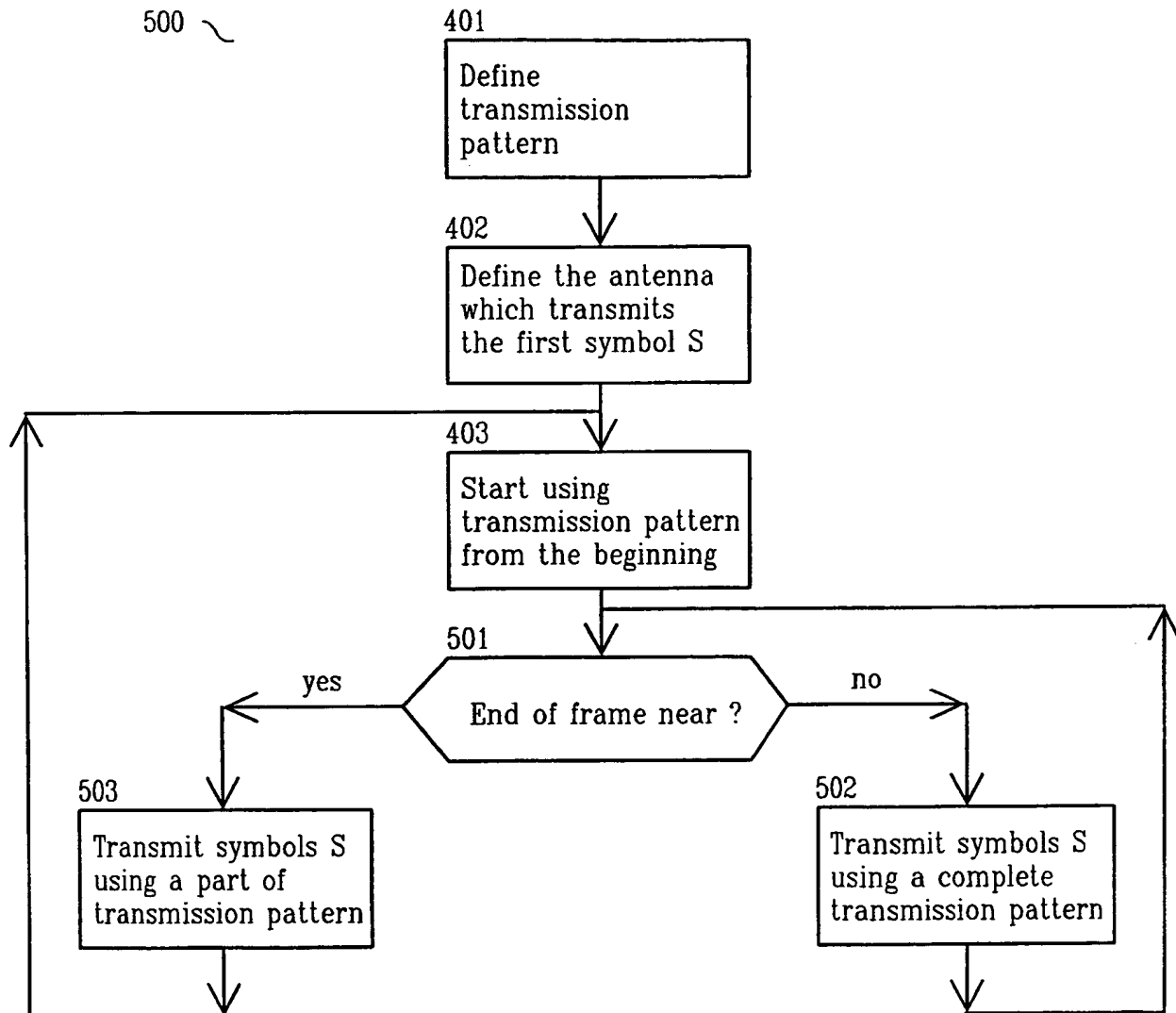


FIG. 5

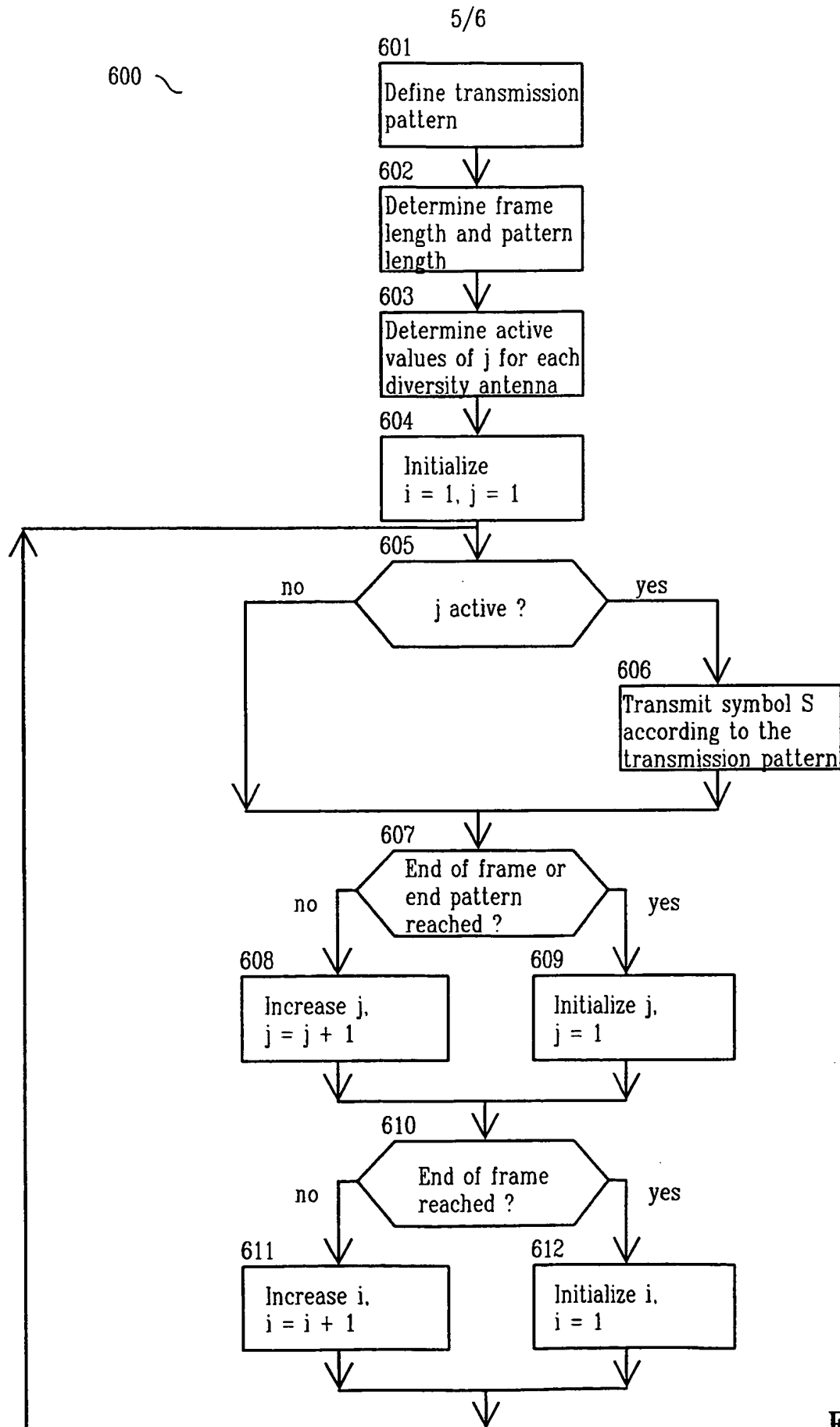


FIG. 6



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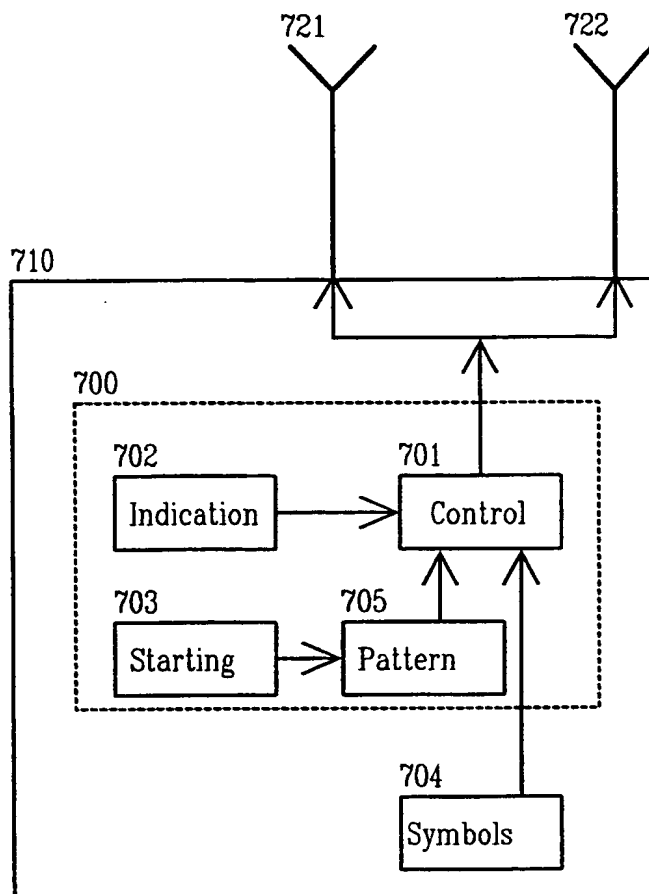


FIG. 7

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00620

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 7/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, H04J, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	IEEE 47th Vehicular Technology Conference, 1997, Volume 3, 1997, pages 1743-1747, H. Olofsson et al: "Transmitter diversity with antenna hopping for wireless communication systems", see section II, III, fig. 1  --	1-14
A	1999 IEEE 49th Vehicular Technology Conference, This Conference was Held: 16-20 May 1999, pages 1545-1549, vol. 2, M. Raitola et al: "Transmission diversity in wideband CDMA", see section 2.1; 5.1  --	1-14

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00620

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	Wireless Communications and Networking Conference, 1999. WCNC.1999 IEEE, pages 669-673, vol. 2, This Conference was Held: 21-24 Sept. 1999, D. Rajan et al: "Transmit diversity schemes for CDMA-2000", see section 2.2  --	1-14
A	WO 96089908 A2 (INTERDIGITAL TECHNOLOGYCORPORATION), 21 March 1996 (21.03.96), claim 1  -- -----	1-14

# INTERNATIONAL SEARCH REPORT

Information on patent family members

03/10/00

International application No.

PCT/FI 00/00620

WO 96089908 A2 21/03/96 NONE

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